THE THERMOLUMINESCENCE (TL) OF BARYTES WITH A SMALL RETRAPPING FACTOR

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A barytes mineral was picked in which the retrapping probability, A_z, is lowere than the recombination probability, A_r, in a thermally stimulated recombination process. This is a rare case in minerals. The TL phenomenon in our specimen is explained by the presence of microdefects whose concentration and distribution are such as to fullfil the conditions for $A_z<A_r$ due to the geological history of the mineral.

In general, it has been assumed that minerals, as multicomponent systems with several different trapping centers, in their TL phenomenon always exhibit the property of $A_z>A_r$. For our specimen, however, this assumption is not valid. It is certain that the conditions under which it was being formed and its geological history were conducive to its departure from usual cases. Such anomalous cases are more and more frequently a subject of study in the field of mineral physics.

Under the same experimental conditions, the specimen under study exhibits a medium thermoluminescence effect relative to other specimens of the same colour. Figure 1 shows the TL glow curve (1) of natural TL. The peak of the TL curve appears at a temperature of 220°C. Using formulae derived by different authors the following basic quantities defining trapping centers were calculated: the thermal activation energy of trapping centers, E_T, and the frequency factor, p_o.

In barytes crystals several paramagnetic colour centers have been found. These are inorganic radicals of the type of $[SO_m]^n$, O^- and S_2^-. They may capture an electron and become trapping centers, which is of significance in studying TL. According to the published data, in a bluish-grey barytes the paramagnetic centers are SO_2^-, SO_3^- and SO_4^-. Since the specimen under consideration is semitransparent (colourless) in a thin layer, for this colour of barytes the paramagnetic centers are the SO_3^- radicals. These are radicals represented by the $|SO_4|^{2-}$ tetrahedron with an oxygen ion vacancy. When it traps an electron (just as a F-center does), it distributes it throughout the SO_3^- radical, preserving its individual properties of a free radical.

Table captions

Sampl No.	P_o (s^{-1})	E_T (eV) Lushchik	Gross-weiner	Chen
N_1^o	$3,5\cdot10^8$	0,69	0,74	0,65

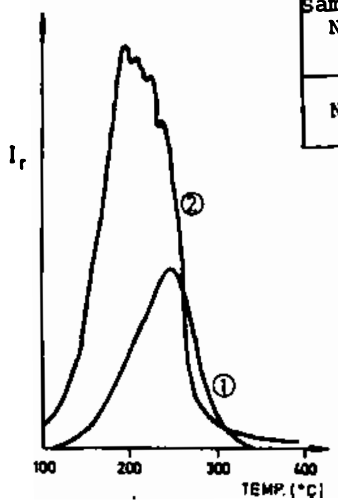

Fig. 1

Curve 2 in Fig.1 was obtained after irradiation of the mineral with gamma rays at a dose of 3.6×10^6 rad. The thermoluminescence curve was recorded 30 days after irradiation, the mass and amplification factor being smaller by a factor of 5 and 10 respectively in recording the light signal than those in recording natural thermolumimescence. Curve 2 exhibits new peaks on the descending side, which turned out to be reproducible. This fact speaks in favour af a stable electron-hole state in the crystal structure also on irradiation under laboratory conditions. It is evident that its total light emitted has considerably increased. The specimen investigated might serve as a dosimeter for recording small radiation doses:

In $BaSO_4$ and barytes activated by rare earth elements the spectral distribution of the light emitted in TL process has been studied. In natural minerals, however, there are at the same time two or several activator ions, depending on the geochemical effects exerted in the process of mineral formation. The existence or change in concentration ratio of activator ions may lead to a number of specific features related to the mineral luminescence.

The spec tral distribution was determined at the Laboratory of Atomic and Molecular Spectroscopy of the Institute of Physics in Belgrade, where facilities are available for recording very weak light signals, of the order of 10 photons. At the glow peak temperature it has been found that light of a wavelength of λ=405 nm is predominant, which corresponds to the Pb ion. It is assumed that isomorphic exchange of the Ba^{2+} ion with the Pb^{2+} ion from the lead sulfate mineral anglesite or from some other lead mineral took place. On irradiation of the mineral the following events occur at the same time: electrons are trapped by paramagnetic SO_3^- centers, bluish-grey colour centers arise, and the $(Pb^{3+}e^+)$ holes are trapped by luminescence centers. By imparting the thermal activation energy, E_T, electrons are released from trapping centers and the following process takes place :

$$(Pb^{3+}e^+) + e^- \rightarrow (Pb^{2+})^* \rightarrow Pb^{2+} + h\nu_{405}$$

It is known that very low concentrations of the Pb^{2+} ion in different crystallophosphors may serve as activator. This is true also for minerals.